116 MeV Beam Parameters

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15 Nov 88

Two approaches —

1. It's no worse than the 200 MeV beam:

   a) Longitudinal

   $\frac{\Delta p}{p} = 2.5\times10^{-3}$ FW See LU-114 E. McCrory

   $\Delta\varphi = 8^\circ$ 90%

   $\frac{\Delta E}{E} = \beta^2 \frac{\Delta p}{p} = 8.01\times10^{-4}$

   $\Delta E \Delta t = 2.52\times10^{-5}$ eVs

   $\Delta E \Delta\varphi = 7294$ keVdeg

   $\varepsilon_\varphi = \frac{\Delta E \Delta\varphi}{\pi} = 2322$ keVdeg ± 50% (E. McC)

   b) Transverse

   $\varepsilon_x = 5.8\,\pi$ mm mrad (normalized, 95%)

   $\varepsilon_y = 7.7\,\pi$ mm mrad (normalized, 95%)

2. Using the (questionable) 10 MeV emittance information find the 116 MeV beam by PARMILA. Use as a further condition that the PARMILA run must agree at 200 MeV:

   a) Longitudinal

   $\varepsilon_\varphi = 2120$ keVdeg (14 Nov 88 E. McC)

   $\beta_\varphi = 18$ deg/MeV

   $\alpha_\varphi = 0.64$

   b) Transverse

   $\varepsilon_x = 6.5$ mm mrad (95% <u>un</u>normalized)

   $\beta_x = 3.1$ m

   $\alpha_x = -0.14$

   $\varepsilon_y = 5.4$ mm mrad

   $\beta_y = 5.88$ m

   $\alpha_y = -0.06$

To use TRACE3D and the Sacherer result that the second moment of a uniform distribution of $\sqrt{5}\sigma$ of the original distribution depends mostly on the linear part of the space charge force one wants five times the <u>rms</u> values of the emittances

By fitting ellipse to 1000 particle dist. (E. McC 11/14)

$\varepsilon_z = 1490\pi$ keV deg (at 805 MHz)

$\varepsilon_x = 1.89\ \pi$ mm mrad rms normalized

$\varepsilon_y = 1.79\ \pi$ mm mrad

The numbers to be used with TRACE 3D are (at 805 MHz)

$\varepsilon_\phi = 7450\ \pi$ keV deg (about 92%)

$\varepsilon_x = 13.8\ \pi$ mm mrad (90%(+) unnormalized)

$\varepsilon_y = 13.1\ \pi$ mm mrad (92% - unnormalized)

The comparison of what has been used before and what appears from the present information most nearly believable

	old	new
β_x	2.49	3.10
α_x	0.00	-0.14
ε_x	9.46	13.8
β_y	5.25	5.88
α_y	-0.41	-0.14
ε_y	9.46	13.1
β_ϕ	0.068	0.072
α_ϕ	0.30	0.64
ε_ϕ	25000	7450

Why are the numbers different?

1) The difference in the α's + β's reflects E McC. calculation only.

2) The emittances were taken previously as Elliott's 95% values; in the present tabulation they are precisely $5 \times \sigma$

From: ALMOND::MCCRORY 14-NOV-1988 16:33
To: MACLACHLAN
Subj: 1000 particle data file and summary of work

Here is an informal overview of my third iteration of my attempts to determine the beam parameters at 116 MeV (tank-5-out) using computer simulations. Six-vectors are produced by the Parmila program and are dumped onto the Vax disk as outlined below.

The data are contained in:
USR$DISK4:[MCCRORY]PARMILA_OUT_ASCII.DAT

The input file to Parmila specifies a Linac which, I presume, has the same mechanical structure as the existing Linac. The quad gradients are obtained from ACNET. The input conditions are taken from a 10 MeV emittance run, but this run is of dubious quality because we now believe that the accuracy of the emittance probes has been severely compromised by inadequate RF shielding in the signal cables. The primary criterion is to match the parameters at 200 MeV, where we think we know the beam parameters accurately, using beam parameters at 10 MeV which are not too different from the measured parameters.

Number of particles in this run is 1000.

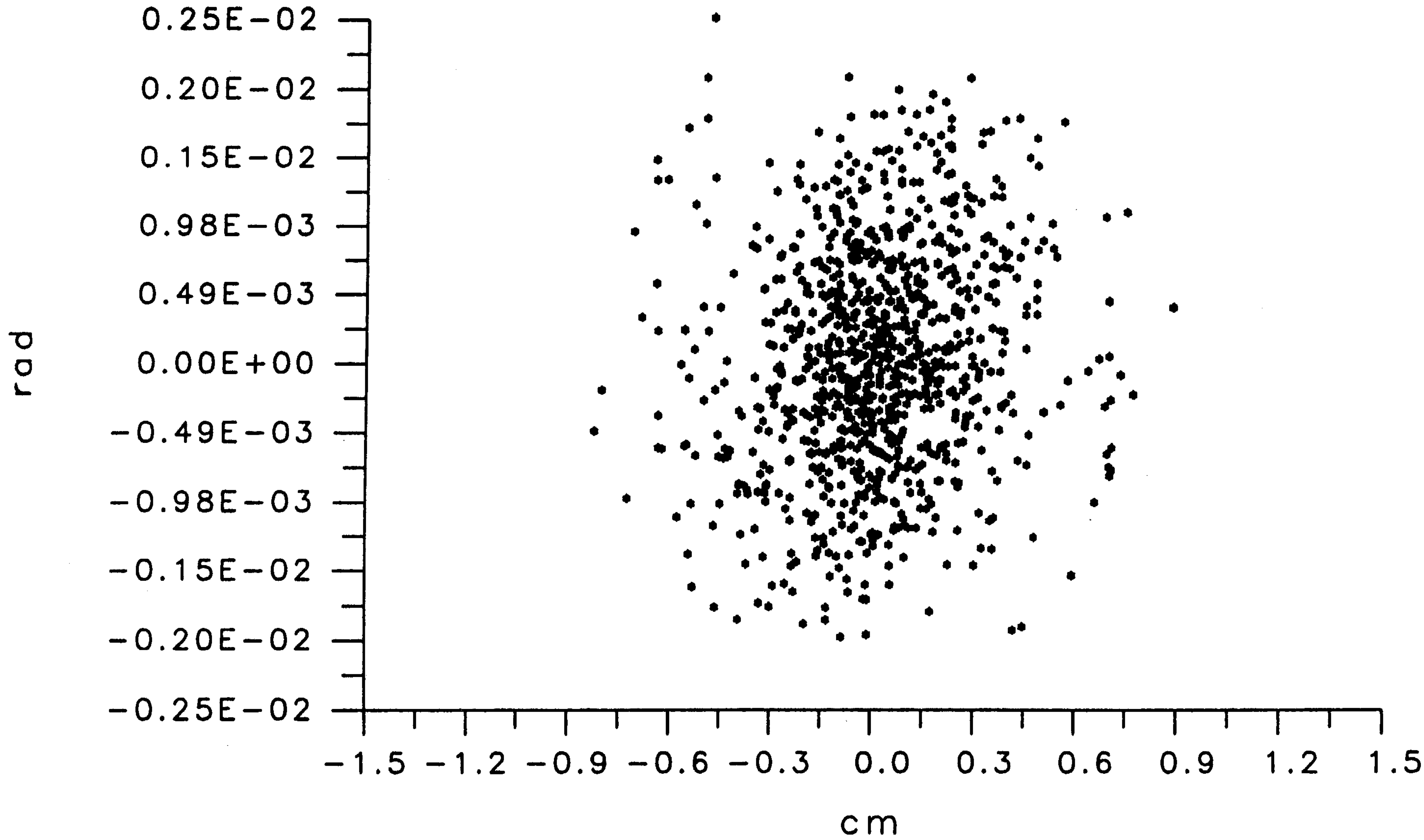
The Tank 5 data is sampled right at the end of the tank--no drift at all.

Column (1) is from the Parmila run, T5-out; Column (2) is Parmila, T9-out;
Column (3) is our best guess for actual T9-out beam parameters (Chuck Schmidt's 200 MeV program and my Trace-3D run, which agree okay).

The longitudinal emittance at 204 MeV comes from these data:
delta-p/p = 0.0025 +- .0005 (from spectrometer and BPM data)
delta-phi = 8 +- 3 degrees (approximate accuracy for measuring this quantity)

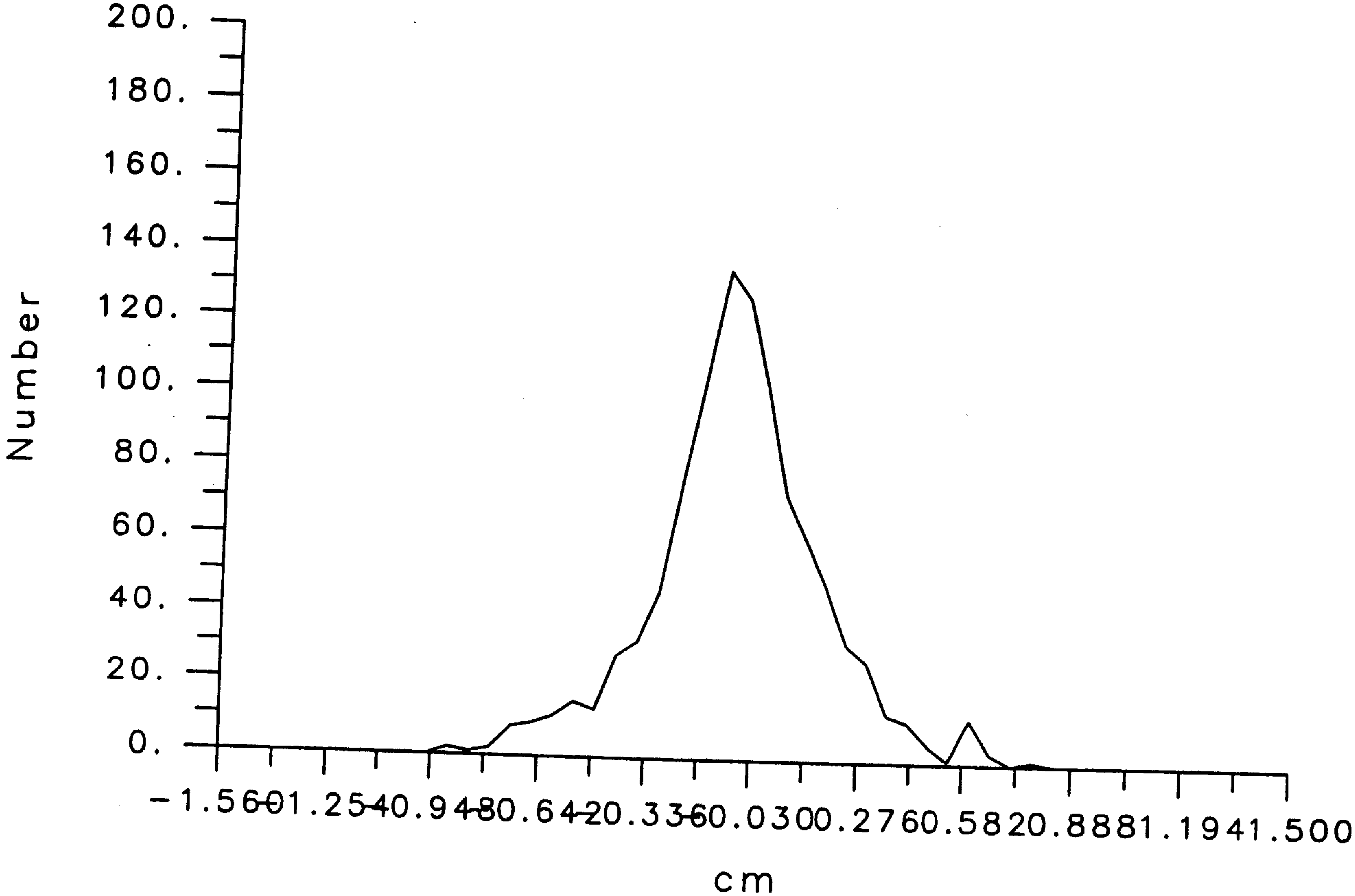
Quantity	(1) 116 MeV	(2) 204 MeV	(3) 204 MeV, real
Alpha-X	-.14	.83	+4
Beta-x	310 cm	1540	1300
Emit-x	6.5 mm mr	6.7	6
Alpha-y	-.06	-1.2	0 to -1?
Beta-y	588	617	350
Emit-y	5.4	6.7	7
Alpha-z	.64	-.58	unknown
Beta-z	18 deg/MeV	7.9	unknown
Emit-z	2.12 MeV-deg	2.44	1.8 +- 0.8

I have done various runs with Trace-3D, using the last four quads in Tank 5. I can create a match 50 or 75 cm downstream of Tank 5 quite easily in the range
alpha-x = alpha-y = 0
alpha-x = 400 to 550 cm
alpha-y = 100 to 150 cm

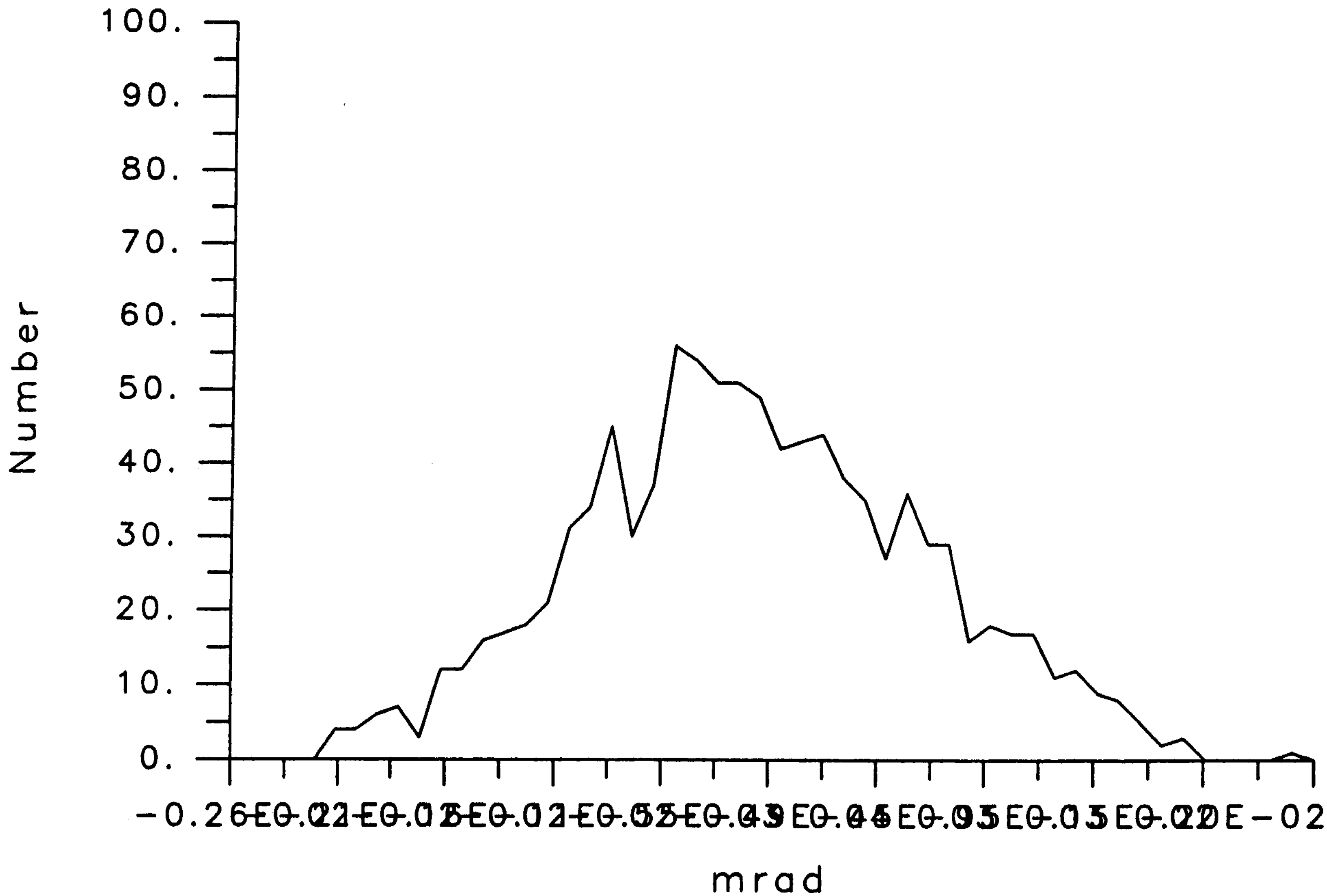


Horizontal Phase Plane

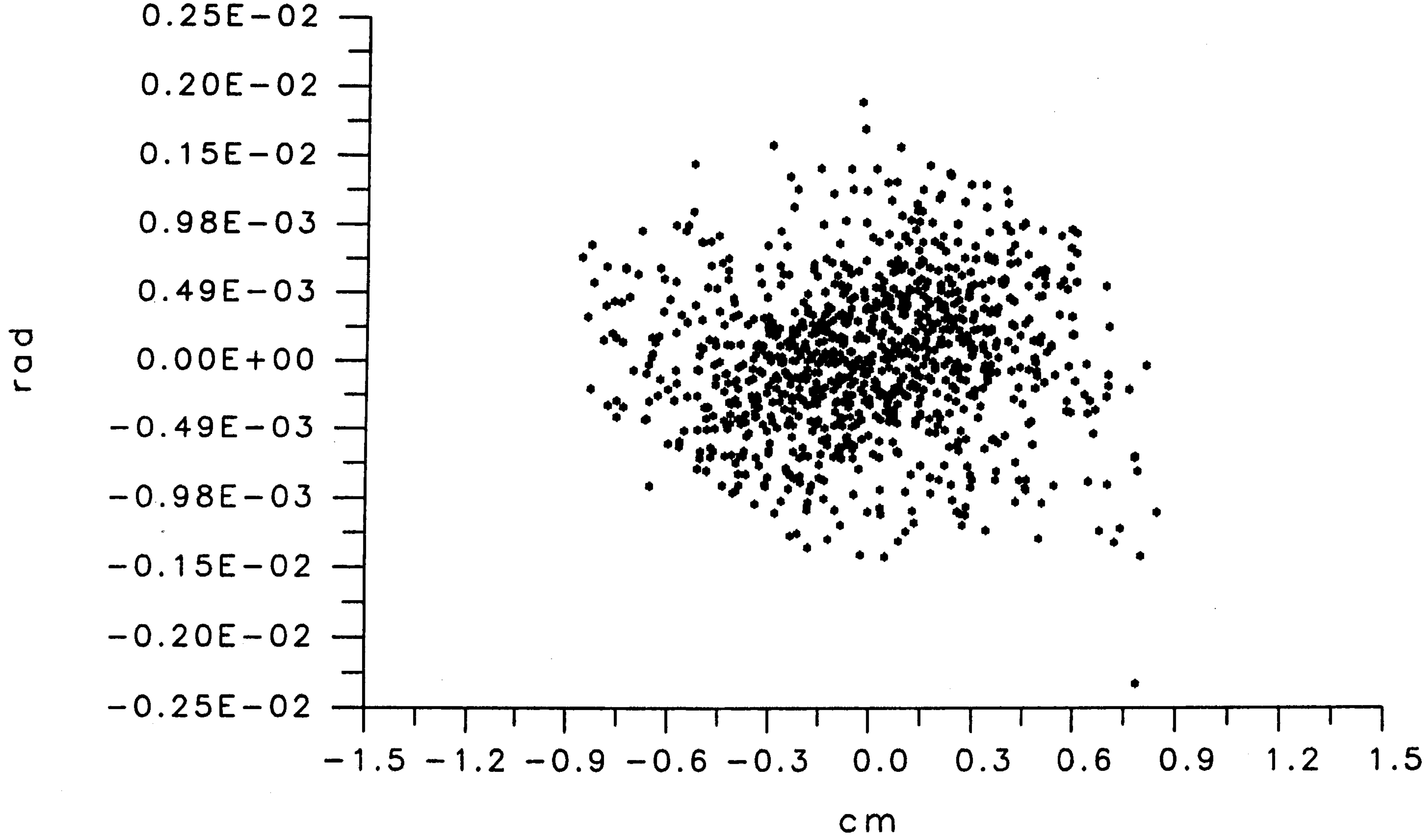
Horizontal Displacement Projection

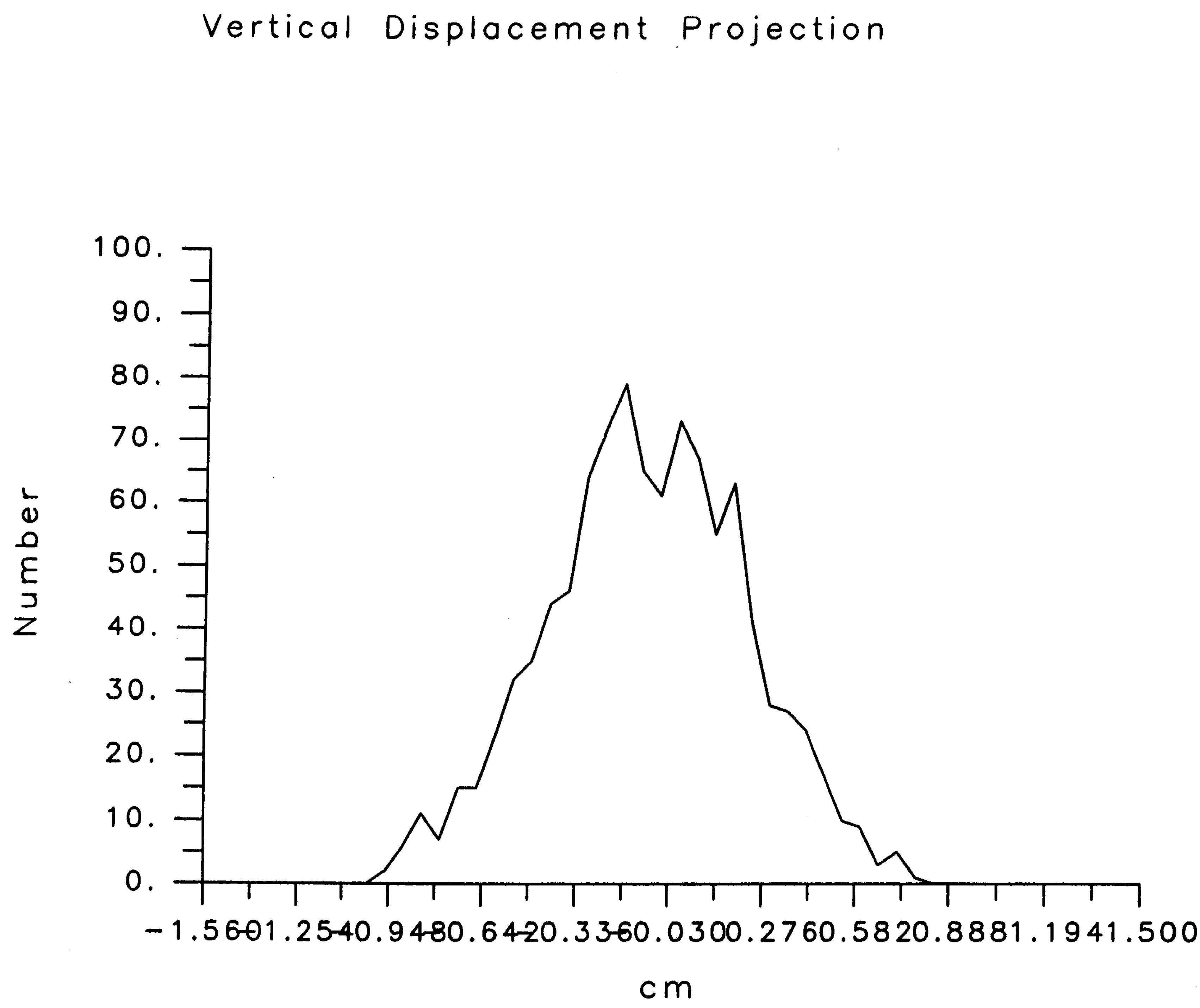


Horizontal Angle Projection

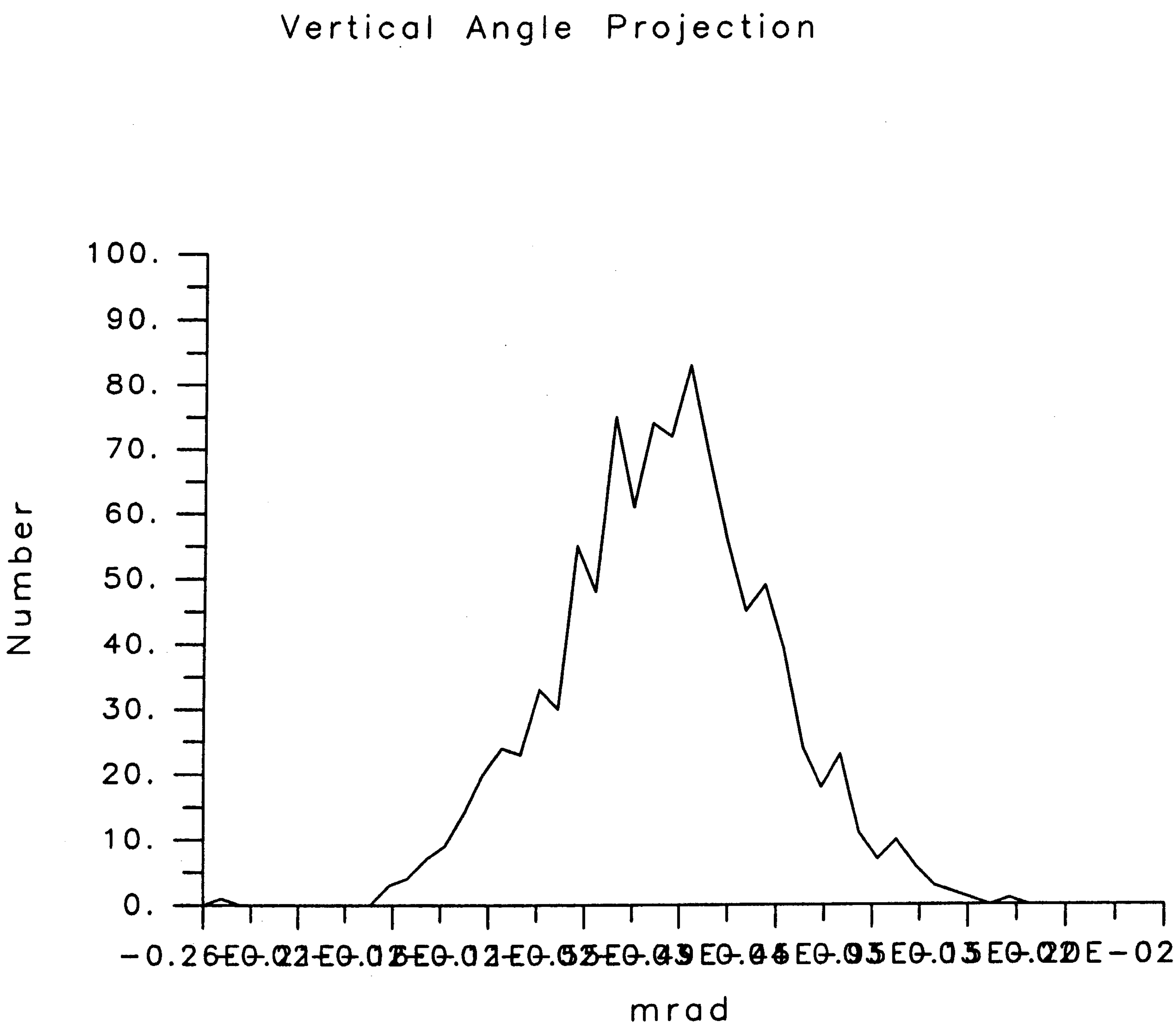


Vertical Phase Plane

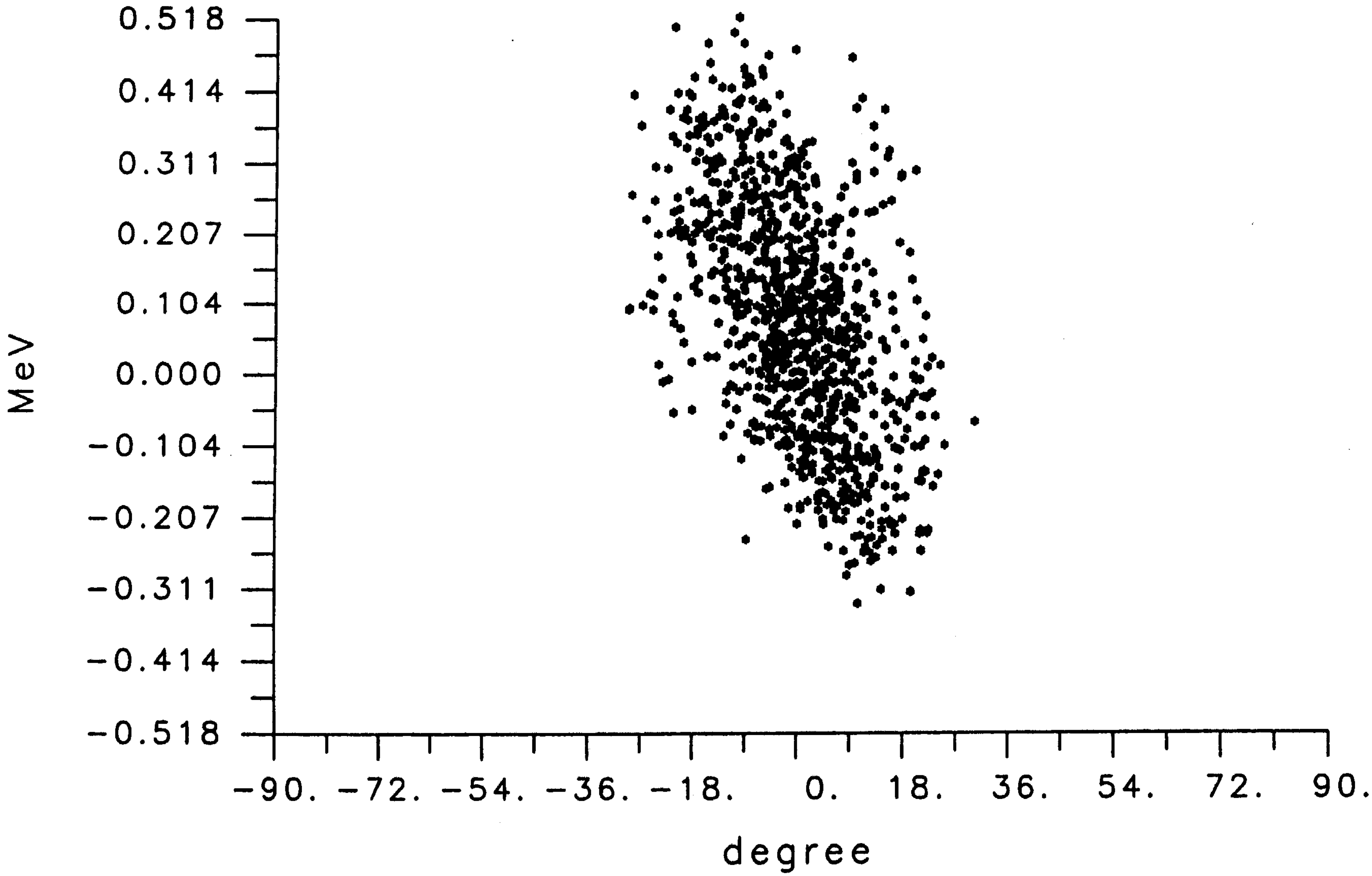


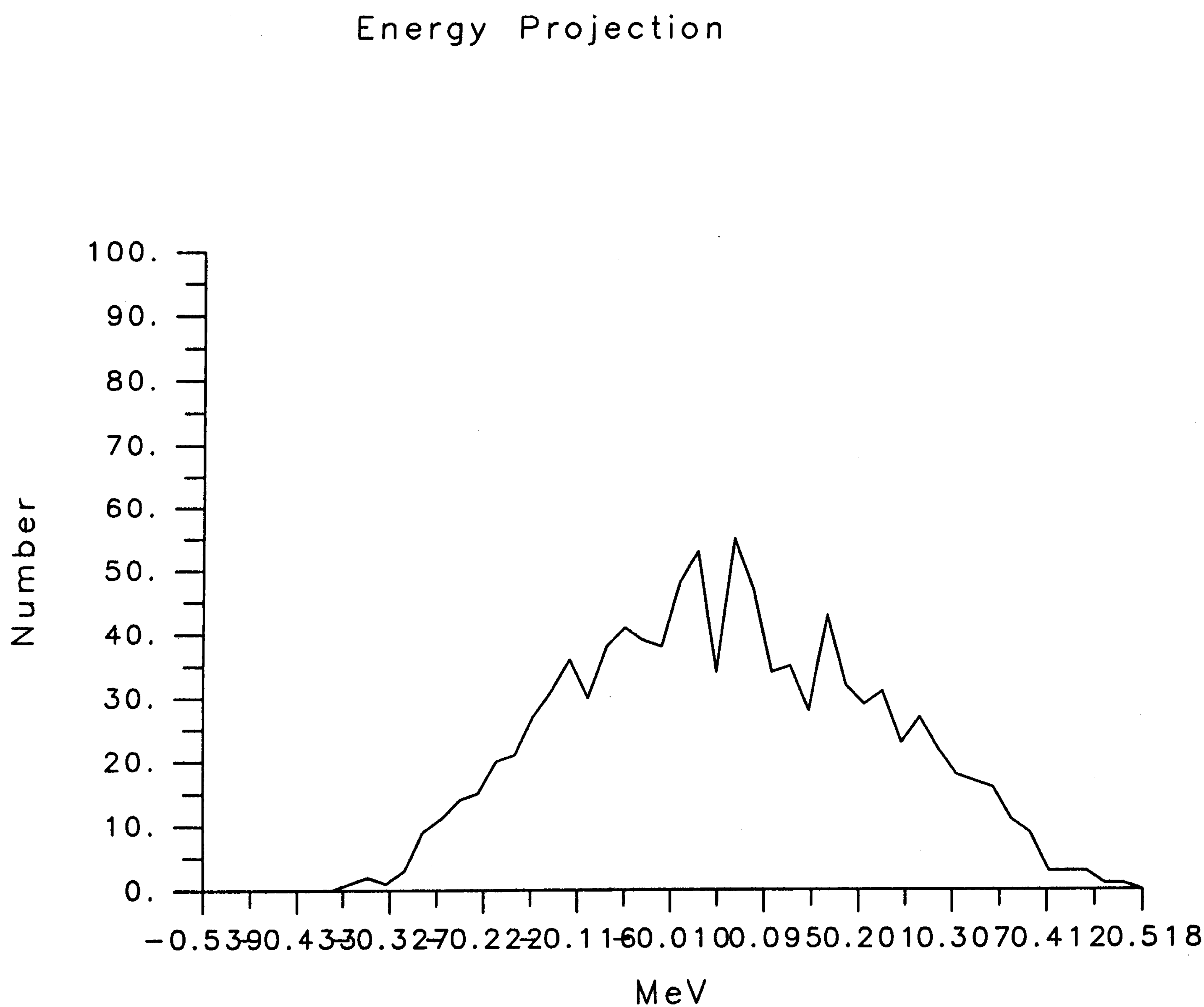


Vertical Displacement Projection
Number
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.
-1.560
-1.254
-0.948
-0.642
-0.336
-0.030
0.276
0.582
0.888
1.194
1.500
cm


Vertical Angle Projection
Number
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.
mrad

Longitudinal Phase Plane




Energy Projection
Number
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.
-0.53-90.43-30.32-70.22-20.11-60.0100.0950.2010.3070.4120.518
MeV

Phase Projection